PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION See Form PCT/IPEA/416	
IP20031107OE		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/NO2003/000445	30-12-2003	30-12-2002
International Patent Classification (IPC) or national classification and IPC		
G05D 1/02, G05B 13/04, G05B 23/02 // B63H 25/00		
Applicant		
MARINE CYBERNETICS AS et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☐ *(sent to the applicant and to the International Bureau)* a total of 7 sheets, as follows:
      ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s))
      _____, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☐ Box No. VII Certain defects in the international application
   - ☒ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
20-04-2004	22-03-2005
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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/NO2003/000445

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on a translation from the original language into the following language _____, which is the language of a translation furnished for the purposes of:

☐ international search (under Rules 12.3 and 23.1(b))
☐ publication of the international application (under Rule 12.4)
☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

☐ the international application as originally filed/furnished

☒ the description:
pages 1-27 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____

☒ the claims:
pages _____ as originally filed/furnished
pages* _____ as amended (together with any statement) under Article 19
pages* 1-7 received by this Authority on 22-11-2004
pages* _____ received by this Authority on _____

☒ the drawings:
pages 1-6 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____

☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/figs _____
☐ the sequence listing *(specify)*: _____
☐ any table(s) related to the sequence listing *(specify)*: _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/figs _____
☐ the sequence listing *(specify)*: _____
☐ any table(s) related to the sequence listing *(specify)*: _____

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-30	YES
	Claims		NO
Inventive step (IS)	Claims	1-30	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-30	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:

D1: WO 9214216 A1
D2: SU 508713 A, Patent abstract of database WPI
D3: US 2003139916 A1 (Published 24 July 2003)

The applicant describes the problem of controlling a marine vessel when the physical process is influenced by unpredictable external events. To stay in a safe and stable state the control system must be aware of sensor signals to regulate suitable instrument, e.g. sensors, actuators. Therefore, the intention of the applicant is to predict the system from on-line sensor signals interacted with simulated sensor signals from an external computer to maintain a properly working system in an accurate and safe state position.

Document D1 discloses an interactive diagnostic system and method for an automotive vehicle. The vehicle has a network of sensors and actuators for independently sensing and actuating a number of different functions within the vehicle. An onboard computer monitors the sensors and controls the operation of the actuators. An interactive diagnostic work station utilizes its own external computer for continuously, in real time, monitoring and analyzing electronic data entering and/or exiting the onboard computer of the vehicle. Means are provided for selectively and temporarily disconnecting one or more specific sensors or actuators from the vehicle's onboard computer. The work station's external computer arrangement is temporarily connected with these sensors for simulating the

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Box V

operation of one or more specific sensors or actuators independent of the actual operation of these sensors. The external computer simulate the sensors they would operate under simulating conditions (see page 6, line 11 - page 8, line 4; page 10, line 1 - page 12, line 19; page 14, line 16 - page 15, line 22; figure 2; claim 1).

Document D2 discloses a system for automatic control of a ships course at sea. A testing station on-board on the ship contains a mathematical model of the ship, control desk, actuator, steering simulator and a feedback sensor. The qualitative characteristics of the control system on test are determined more realistically by having regard to the irregular nature of rough sea in selecting the dynamic characteristics required and in determining the parameters of the real system.

The difference between D1 respectively D2 and the claimed invention, according to claims 1 and 18, is that the claimed invention solves navigation problems of sensors or actuators related to dynamic positioning of a vessel in drilling operation. An external simulation computer and an on-board control system are in continuous interaction to each other. The external computer receives and computes a simulated signal out of a command signal from the on-board computer, which disconnects one or several sensor signals in the system. Combination of the new simulated signals for disconnected specific desired sensor signals and remaining sensor signals in the system are connected together on the on-board computer to be tested for the one or few sensor signals. The system provides a proper response in situations of which connected sensor is properly working. This reduces the need of test of individual sensors or actuators separately, and reduces unpredictable events to keep and remain in an accurate and stable position.

Hence it is not obvious for a person skilled in the art to modify D1 or D2 to solve the same problem as referred in the claimed invention.

In light of the arguments stated above, the invention according to claims 1-30 is novel and industrial applicable, and is considered to involve an inventive step.

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The indicating statement for mentioned technical features of "propellers (16)" and "control devices (18)" in claims 5-7 are not defined in claim 1. Any dependent claim shall refer to the state of additional features claimed. Therefore, claims 5-7 shall be constructed and refer to all the limitations contained in the claim to which it refers to.

Amended Claims

1. A method for testing a control system (2) in a marine vessel (4), in which said control system (2) comprises control and monitoring of said vessel (4) with control signals (13) to one or more actuators (3), said method comprising the following sequential steps:

* acquisition in real time of sensor signals (7) to said control system (2) from one or more sensors (8) over a first sensor signal line (12) to said control system (2);
* acquisition of command signals (9) to said control system (2) from a command input device (10) over a second signal line or command signal line (11) to said control system (2);
* computation in a control algorithm (31) in said control system (2) on basis of one or more of said sensor signals (7) and said command signals (9), and sending of said control signals (13) over a third signal line (14) to said actuators (3)
* disconnection of one or more of said sensor signals (7) from one or more of said sensors (8) or of said command signals (9) from said control input devices (10), so that the selected sensor signals (7) or command signals (9) do not flow to said control system (2), and replacement of one or more of said disconnected sensor signals (7) or said command signals (9), with corresponding simulated sensor signals (7') or simulated command signals (9'),

characterised in

that said simulated sensor data (7') or command signals (9') are generated in a remote test laboratory 40) with respect to said vessel (4) and transmitted over a communication line (6) via one or more of said signal lines (12, 14) to said control system (2);

* continued computation of control signals (13') in said control system (2) on basis of said real and/or said simulated sensor signals (7a or 7a', 7b or 7b', 7c or 7c', ..) or said real and/or said command signals (9a or 9a', 9b or 9b' , 9c or 9c', ..), and
* transmitting said control signals (13') via said communication line (6) to said remote test laboratory (40).

2. The method of claim 1, comprising simulation in a simulator (30) in said test

laboratory (40) by means of an algorithm (32) of a new dynamic state of a vessel model (4') on basis of said control signals (13').

3. The method of claim 1, in which said sensor signals (7) comprise one or more of the following sensor parameters from said sensors (8):
- a position (7a) of said vessel from position sensors (8a), such as GPS receivers (8a); hydroacoustic position sensors (8h), integrating acceleration sensors, etc.;
- a course (7b) from course sensors (8b), e.g. a gyrocompass or some other compass;
- a velocity (7c) from a velocity sensor (8c) or an integrating acceleration sensor;
- a wind speed (7d) and a wind direction (7e) from an anemometer (8d, 8e);
- a roll angle (7f) from a roll angle sensor (8f);
- a pitch angle (7g) from a pitch angle sensor (8g).

4. The method of claim 1, in which said control signals (13) comprise signals (13a, 13b, 13c) in the form of shaft speed (13a, 13b) for one or more propellers (16) or thrusters (17), and angles (13c) for rudder (18) or thrusters (17) and possible other control devices to achieve one or more of desired position (9a), course (9b), velocity (9c).

5. The method of claim 1, in which said propellers (16) comprise one or more propellers (16a, 16b, 16c, ..).

6. The method of claim 1, in which said control devices (18) comprise one or more rudders (18a, 18b).

7. The method of claim 1, in which said control devices (18) comprise one or more thrusters (17)

8. The method of claim 1, in which said command input device (10) comprises at least one position specification device (10a), a wheel (10b), a velocity specification device (10c), or a device for specification of desired roll angle, pitch angle, heave

compensation, etc. 10x) that gives a command signal for one or more of desired position (9a), desired course (9b), and desired velocity (9c) or some other desired variable (9x), e.g. desired roll angle, desired pitch angle, desired heave compensation, etc.

9. The method of claim 1, in which said remote test laboratory (40) is used to verify that said control signals (13, 13') from said control system (2) on basis of said simulated sensor signals (7') and said simulated command signals (9') in a test, and possibly remaining real sensor signals (7) and remaining real command signals (9), are such that said control signals (13, 13') will lead to a desired state of said vessel (4), and where said control system (2) is certified on basis of this.

10. The method of claim 1, in which the computation in said control algorithm (31) of said control system (2) uses dynamic parameters (5) of the vessel, including mass (m), the axial moments of inertia of the vessel, the mass distribution of the vessel, and hull parameters that determine the geometry of the hull.

11. The method of claim 1, in which the disconnection of said sensor signals (7) from said sensors (8) to said control system (2) is done by means of a switch (15a) on said signal line (12).

12. The method of claim 1, in which the disconnection of said command signals (8) from said command input device (10) to said control system (2) is done by means of a switch (15b) on said signal line (11).

13. The method of claim 1, in which said remote test laboratory (40) is located on land, and where said vessel (4a, 4b, 4c, ...) that is being tested is situated at a long distance from said test laboratory (40), typically between 1 and 20000 km, and where the vessel that is tested is in a harbor, in a dock or a yard, moored, or at the open sea.

14. The method of claim 1, in which failure situations are tested by disconnection one or more of selected signals at the time of said sensor signals (7) or said command

signals (9) to simulate breakdown of components, and where the response of the control system in the form of said control signals (13, 13') and status signals (19, 19') are logged on a logger (15) in said remote test laboratory (40).

15. The method of claim 1, in which failure situations are tested by changing or generating disturbances in a selection of said simulated sensor signals (7'), or by generating external disturbances like weather, wind, electrical noise to said simulated sensor signals (7') that are sent from said remote test laboratory (40) to said control system (2) in said vessel (4), and where the response of said control system (2) in the form of said control signals (13, 13') and said status signals (19, 19') are logged on said logger (15) in said remote test laboratory (40).

16. The method of claim 1, in which new software for said control system (2) on board said vessel (4) is sent from said remote test laboratory (40) over said communication line (6).

17. The method of claim 1, in which said remote test laboratory (40) on basis of a test of said control system (2) and the test result, is used to approve said control system (2) and to certify said control system (2) for regular use in said vessel (4).

18. A system for testing a control system (2) in a marine vessel (4), said control system (2) being arranged to control and monitor said vessel (4), comprising the following features:

* one or more sensors (8) on board said vessel (4) to send one or more sensor signals (7) over a signal line (12) to said control system (2),
* command input devices (10) on board said vessel (4) arranged to send one or more of desired position, course, velocity (9) etc. over a command signal line (11) to said control system (2),
* an algorithm (31) in said control system (2) for the computation of control signals (13) to vessel actuators (3) on basis of said sensor signals (7), said command signals (9), for sending of said control signals (13) over a signal line (14) to said actuators (3),

* one or more communication lines (6) for sending of one or more simulated sensor signals (7') and/or simulated command signals (9'),

characterised by

* said communication line (6) running from a remote test laboratory (40) to said control system (2);
* a simulator (30) including an algorithm (32) for the simulation of a vessel model's (4') new dynamic state represented by new sensor signals (7'), based on the previous state (7, 7'), and said control signals (13, 13'), and dynamic parameters (5) for said vessel (4),
* in which said communication line (6) is arranged for sending back said new simulated state represented by said simulated sensor signals (7') of said vessel model (4') to said control system (2), for continued computation in said control system (2) on basis of the real and/or simulated values of said sensor signals (7, 7') or the real or simulated values of said command signals (9, 9'), of said control signals (13) to achieve at least one of said desired position, course, velocity (9) etc., and
* in which said communication line (6) is arranged for sending of the response from said control system (2) in the form of said control signals (13) as control signals (13') to said remote test laboratory (40).

19. The system of claim 18, comprising a switch (15a) is arranged to disconnect one or more of said sensor signals (7) from said signal line (12) to said control system (2).

20. The system of claim 18, comprising a second switch (15b) is arranged to disconnect one or more of said command signals (10) from said command signal line (11) to said control system (2).

21. The system of claim 18, comprising a third switch (15c) is arranged to disconnect one or more of said control signals (13) from said signal line (14) from said control system (2).

22. The system of claim 18, in which said dynamic parameters (5) of said vessel (4)

enter into said algorithm (31) of said control system (2) for the computation of said control signals (13) to said actuators (3).

23. The system of claim 18, in which said remote test laboratory (40) is provided with a simulator (30).

24. The system of claim 18, in which said communication line (6) for sending of one or more of said simulated sensor signals (7') from said remote test laboratory (40) is arranged to be connected to and disconnected from a first real-time interface (6a), on said remote test laboratory (40).

25. The system of claim 18, in which said communication line (6) is arranged to be connected to and disconnected from a second real-time interface (6b) on said vessel (4), and where said second real-time interface (6b) is arranged to be connected to said signal line (11) to said control system (2) through said switch (15a).

26. The system of claim 18, comprising a simulated command input device (10') for sending of said simulated command signals (9') from said remote test laboratory (40) through said real-time interface (6a) and over said communication line (6) and through said real-time interface (6b) to said control system (2).

27. The system of claim 18, in which the entire of or parts of said algorithm (31) in said control system (2) is arranged to be modified, calibrated or replaced over said communication line (6) from said remote test laboratory (40).

28. The system of claim 18, in which said control signals (13) include signals (13a, 13b, 13c) in the form of shaft speed (13a, 13b) for one ore more propellers (16) or thrusters (17), and angles (13c) for rudders (18) or thrusters (17) or possibly other control devices.

29. The system of claim 18, wherein said sensors (8) include one or more of the

following:

- position sensors (8a), to determine a position (7a), of said vessel (4) such as a GPS receiver (8a), hydroacoustic position sensors (8h), integrating acceleration sensors, etc.;
- course sensors (8b), to determine a course (7b) of said vessel (4), e.g. a gyrocompass or some other compass,
- a velocity sensor (8c) or an integrating acceleration sensor to determine a speed (7c) of said vessel (4);
- an anemometer (8d, 8e) to give (relative) wind speed (7d) and wind direction (7e);
- a roll angle sensor (8f) to give a roll angle (7f);
- a pitch angle sensor (8g) to give a pitch angle (7g).

30. The system of claim 18, wherein said remote test laboratory (4) includes a data logger (15) for logging of the response in the form of said control signals and status signals (13', 19') from said control system (2) to said sensor signals (7, 7').